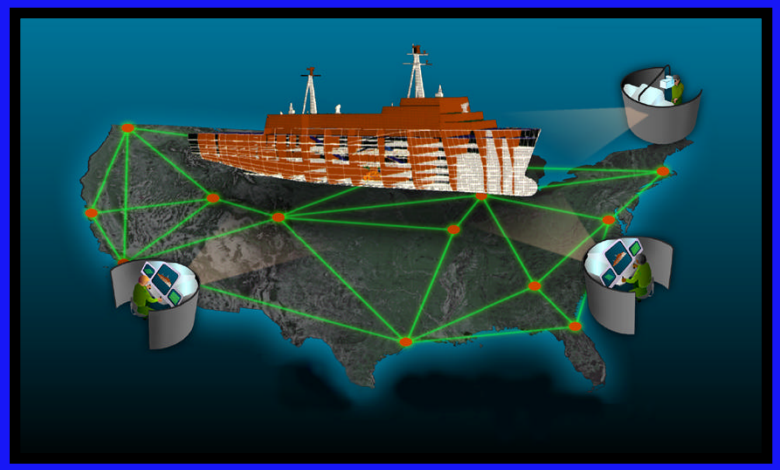
Simulation Based Design and The DMSO High Level Architecture

Presentation For

DMSO AMG

JULY 18, 1996

SBD OVERVIEW



VISION

ENABLE ACQUISITION REFORM BY PROVIDING GEOGRAPHICALLY DISTRIBUTED ENTERPRISES A SYNTHETIC ENVIRONMENT FOR PLANNING, DEVELOPING AND OPTIMIZING A PRODUCT THROUGH VIRTUAL PROTOTYPING

OBJECTIVES

- CHANGE THE ACQUISITION LIFE CYCLE
- ESTABLISH A PHYSICS-BASED SYNTHETIC ENVIRONMENT FOR DYNAMICALLY CONSTRUCTED SYSTEMS
- SUPPORT DISTRIBUTED COLLABORATIVE DESIGN
- PROVIDE MULTIDISCIPLINED OPTIMIZATION
- TRANSITION TO ACQUISITION PLANNERS, ENGINEERING DESIGN TEAMS, AND END-USERS

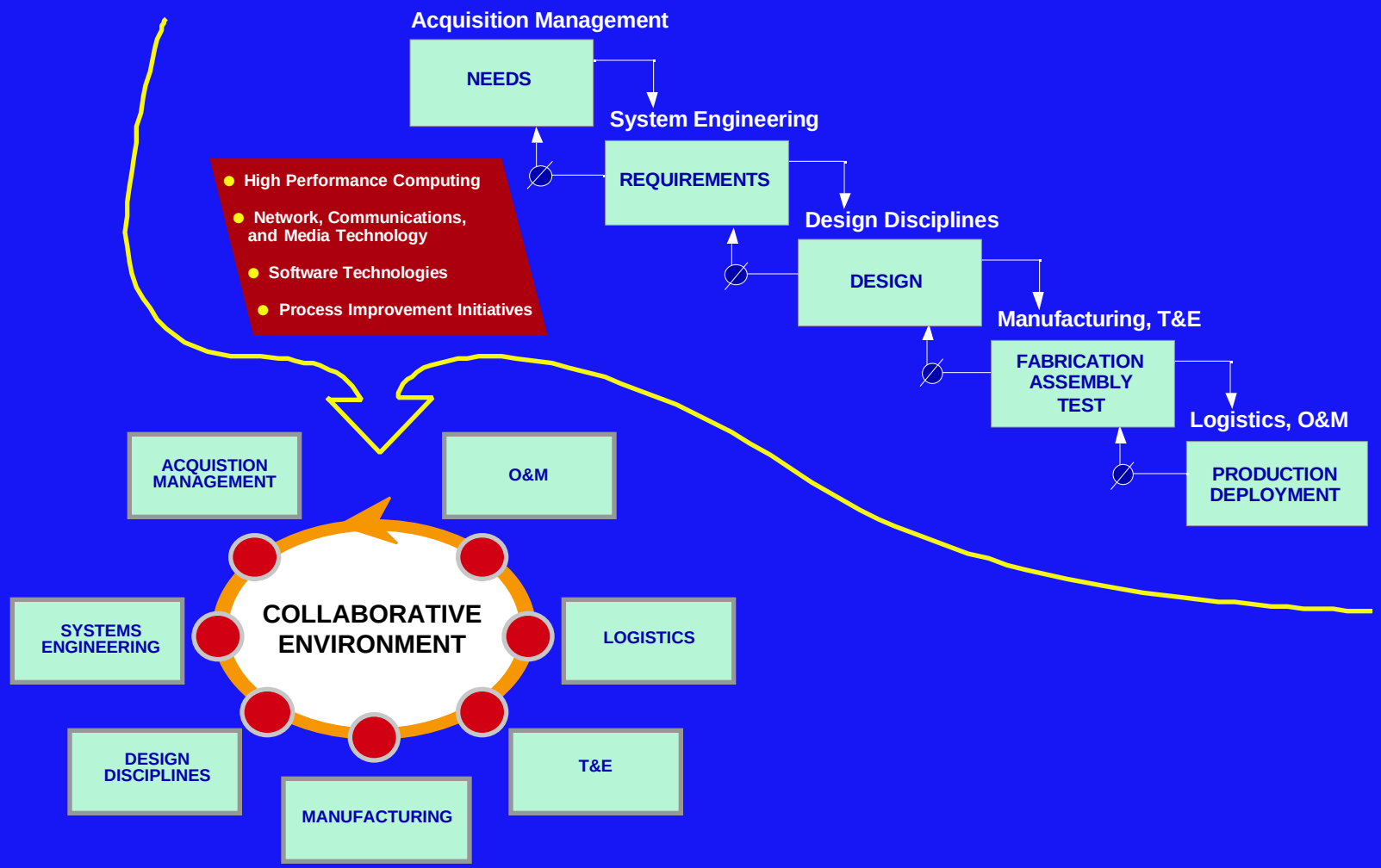
BENEFITS

- IMPROVED PRODUCT QUALITY AT LOWER COST
- INCREASED EFFICIENCY IN ENTERPRISE COLLABORATION
- THOROUGH PRODUCT DEFINITION PRIOR TO COMMITTING DESIGN
- REDUCED ACQUISITION RISK THROUGH BETTER PLANNING
- GREATER ACCURACY IN SCHEDULES DERIVED FROM THE TOTAL DETAILED ACQUISITION PROCESS

ACQUISITION PARADIGM CHANGE

Simulation Based Design

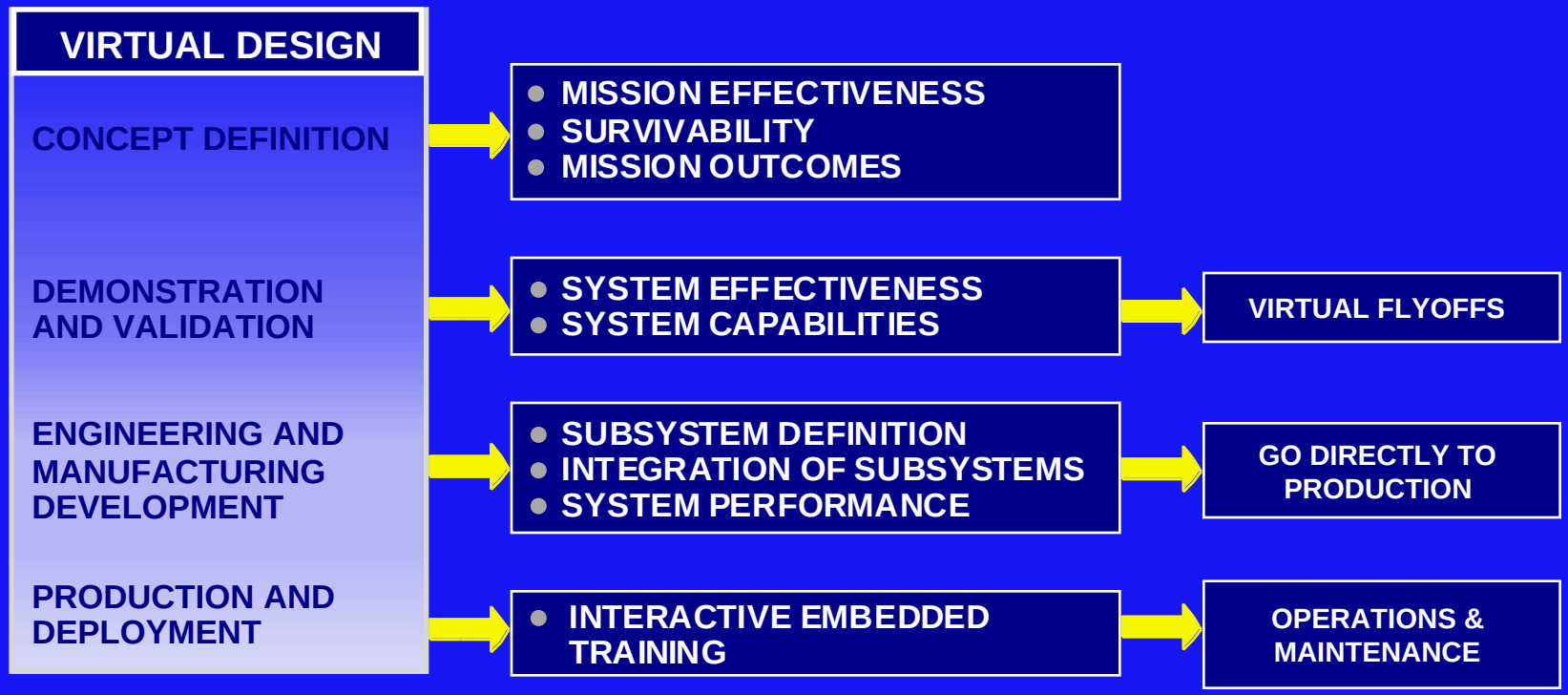
DARPA/TTO



ENABLES SBA

HOW SBD WILL CHANGE ACQUISITION

Simulation Based Design *DARPA/TTO*



- COMPRESS THE LIFECYCLE
  - DO WHOLE LIFECYCLE IN PARALLEL AND PROCEED DIRECTLY TO MANUFACTURING
- UPDATE KEY ASSUMPTIONS MIDSTREAM
  - PROVIDE TECHNICAL, COST, AND SCHEDULE RISKS FOR REAL-TIME IMPACT ASSESSMENT
- INTEGRATE PLAYERS
  - SHARE MODELS AND SIMULATIONS BETWEEN PLAYERS IN FEDERATED SYSTEM

CHALLENGES

- ENABLE SBD SYSTEMS THAT INCORPORATE/INTEGRATE LEGACY TOOLS, DATA, PROCESSES
  - INABILITY IS SHOW STOPPER
- ENABLE MONOTONIC INCREASING FUNCTIONALITY
  - MANY PEOPLE HAVE PUT TOGETHER AN SBD SYSTEM TO SOLVE A PROBLEM BUT SECOND SYSTEM JUST AS EXPENSIVE
- ENABLE BENEFITS COMMENSURATE WITH COSTS
  - COST OF USING COMMON KNOWLEDGE REPRESENTATION, WRAPPING TOOLS CAN NOT BE TOO HIGH
- ENABLE INFORMATION SHARING AND FEEDBACK ACROSS ENTIRE SPAN LIFE CYCLE
  - MUST PROVIDE COMMUNICATION BETWEEN THE ACQUISITION, DEVELOPMENT AND USER COMMUNITIES

LOW COST DOMAIN INDEPENDENCE

APPROACH

SBD CORE

FEDERATION MANAGER

PHYSICAL DESIGN MANAGER

EXPERIMENT MANAGER

SPM

RTI

INTERFACE STANDARDS

CORBA

HLA

LEGACY TOOLS/DATA/PROCESSES

REQUIREMENTS MANAGER

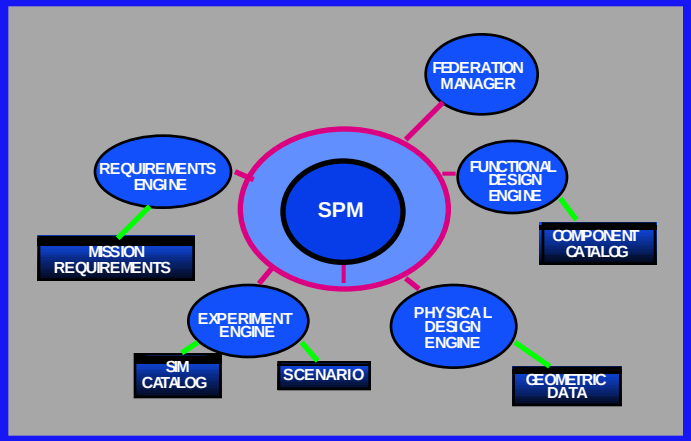
FUNCTIONAL DESIGN MANAGER

SCENARIO

COMPONENT CATALOG

SIM CATALOG

SBD FOR COMBAT SYSTEM DESIGN



CORE COMPONENTS USED TO CONFIGURE SPECIFIC SBD SYSTEMS

VALIDATION EXPERIMENTS

EXPERIMENT	PURPOSE	USER
0	• BASIC CORE BACKBONE	TEAM
DMSO	• OPERATE SHIP IN REALISTIC SYNTHETIC ENVIRONMENT	DMSO ENGINEERING FEDERATION
ESVP	• INTEGRATION OF LEGACY DESIGN TOOLS	NSWC
SURVIVABILITY	• INTEROPERABILITY OF TOOLS WITH MULTIPLE DATA BASES	NAVSEA
ASC	• FEEDBACK BETWEEN WARFARE ANALYSIS AND ENGINEERING DESIGN	NAVY PROGRAMS (SC-21, ARSENAL SHIP,...)

SBD ARCHITECTURE

Simulation Based Design

DARPA/TTO

CAD
- INTERGRAPH
- IDEAS
- PRO-E
- CATIA
- CV-CADDS

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USER APPLICATIONS

DISCIPLINE SPECIFIC ANALYSIS
- STRUCTURAL DYNAMICS
- HYDRODYNAMICS
- SPACE ENVIRONMENT
- THERMAL
- SURVIVABILITY

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SBD COLLABORATIVE INFRASTRUCTURE

SBD SERVICES
- FEDERATION MANAGER
- RUN TIME INFRASTRUCTURE
- 3D VISUALIZATION AND INTERACTION
- MULTI-DISCIPLINARY OPTIMIZATION
- WRAPPER TOOL KIT
- GUIs AND BROWSERS
- MEGA PROGRAMMING

SPM SCHEMA (MODEL, CATALOGS)

MODEL CLASSES
- SYS
  - COMP.
- SHIP
  - HM&E
  - CIC
  - ECS
  - PROP.
  - . . .
- SPACECRAFT
  - STRUCTURE AND MECHANISMS
  - ELECTRICAL POWER
  - DATA PROCESSING
  - PROP.
  - . . .

SBD STANDARDS
- CORBA
- HLA
- VRML
- HTML

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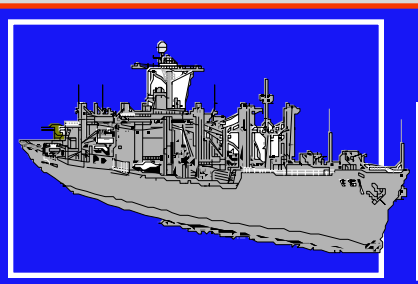
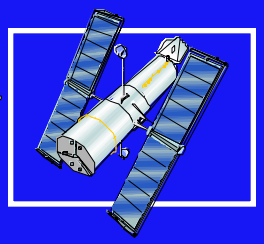
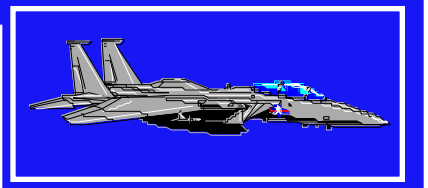




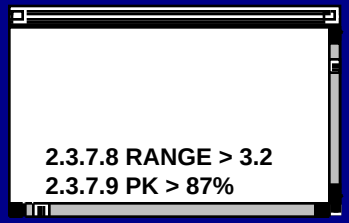
USER GUIs



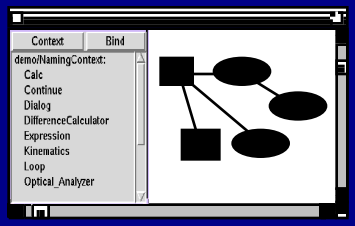
GLUE FOR COLLABORATIVE ENTERPRISE

ESVP CONCEPT OF OPERATIONS

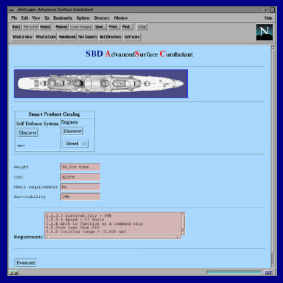
REQUIREMENTS PROTOTYPING



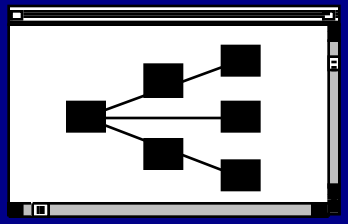
ARCHITECTURE DEFINITION



PHYSICAL LAYOUT



ANALYSIS & OPTIMIZATION



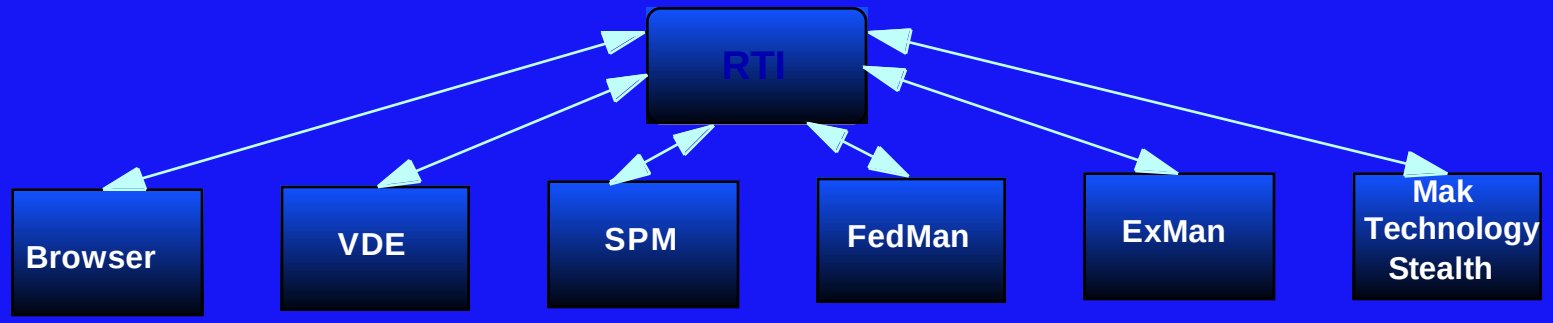
FUNCTIONAL SIMULATION & VISUALIZATION

DEMONSTRATES HOW EXISTING DOMAIN SPECIFIC TOOLS CAN BE INTEGRATED INTO SBD AND OPERATE OFF THE SPM

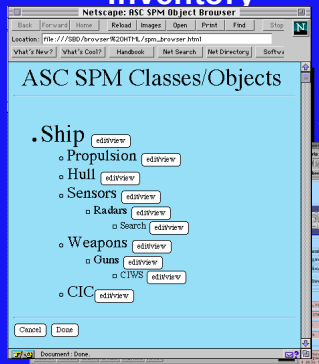
Simulation Based Design

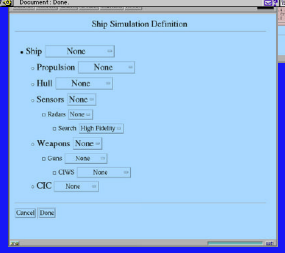
COMBAT SYSTEM DESIGN PROTOTYPE

DARPA/TTO



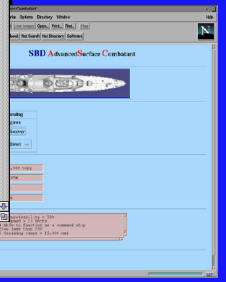
Project Inventory



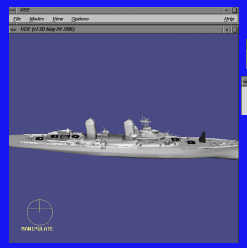


Simulation selection

Ship Viewer



3D Physical Layout



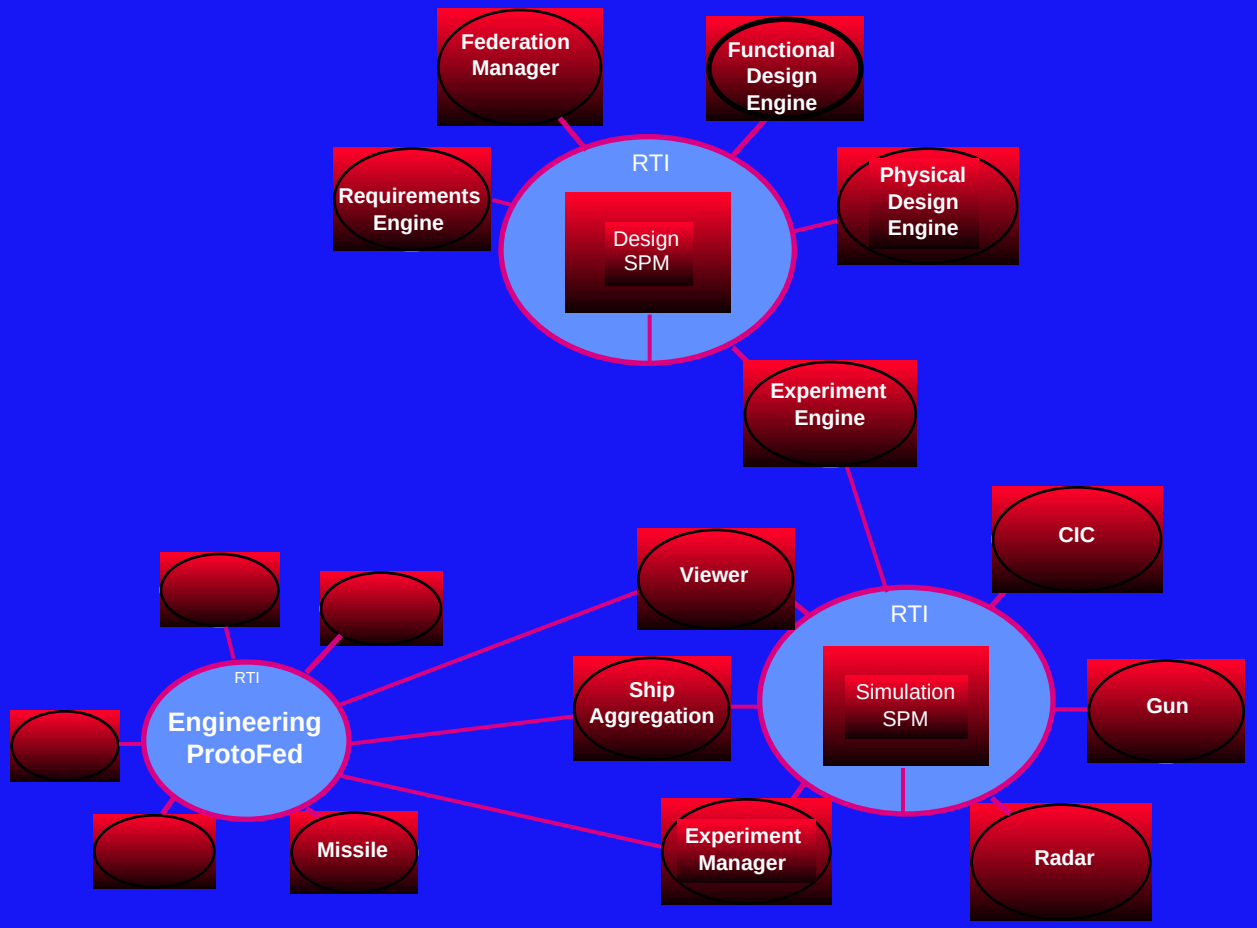
Simulation Federation Manager

Exercise configuration

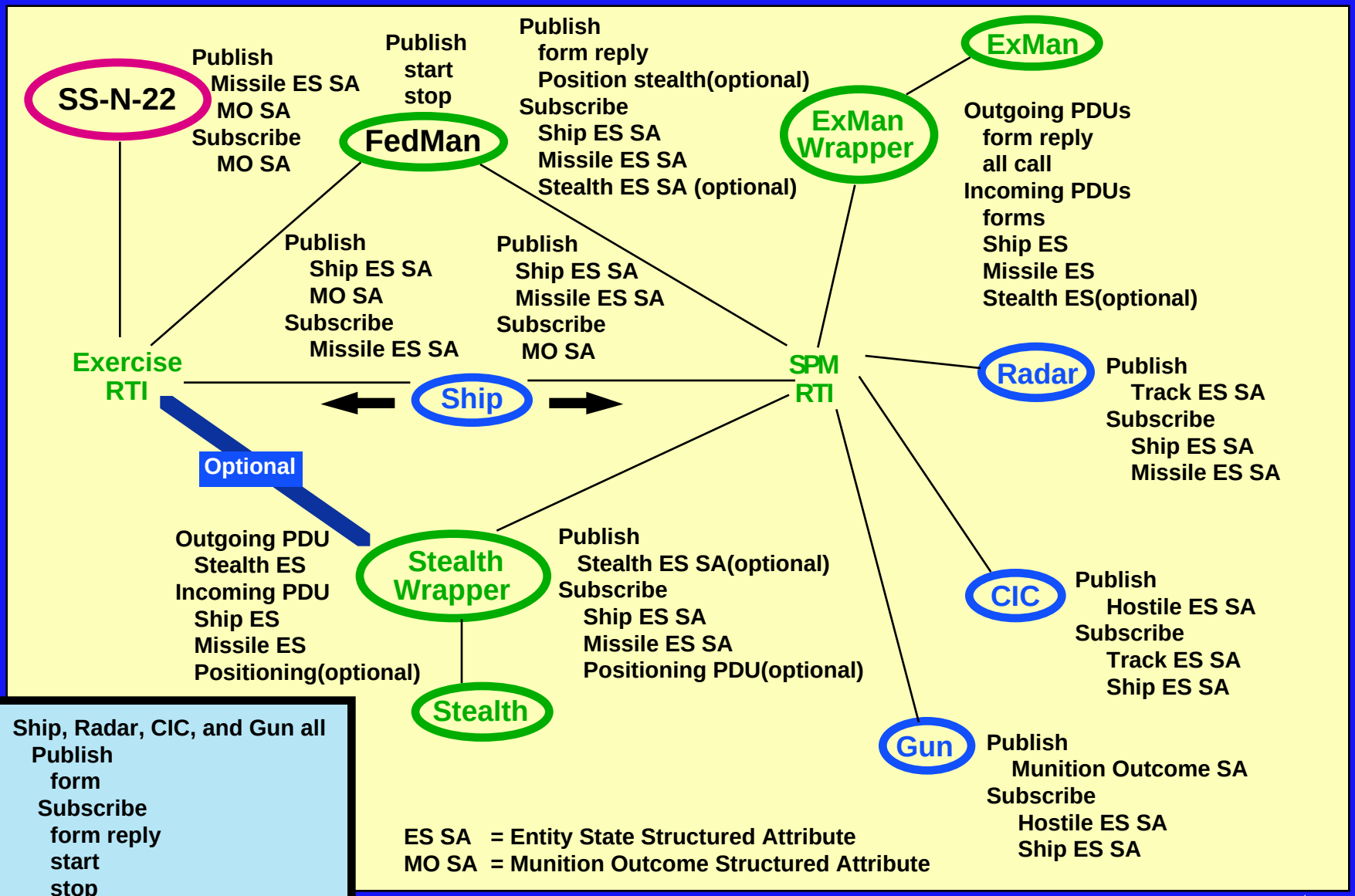
3D viewer

ESVP/ENGPROTOFEDERATION

Simulation Based Design *DARPA/TTO*



EXERCISE FOM

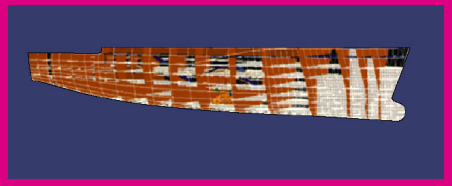


DESIGN FOM

SPM
- publish
  - Ship
- subscribe
  - Checkin, Checkout

VDE
- publish
  - Checkin, Checkout
- subscribe
  - Ship

Ship - the product model
- shipid: id
- structures: - list of part ids
- connections (part, part) : list of connections
- location (part) : location of part wrt platform
- geometry (part) : VRML rep of part

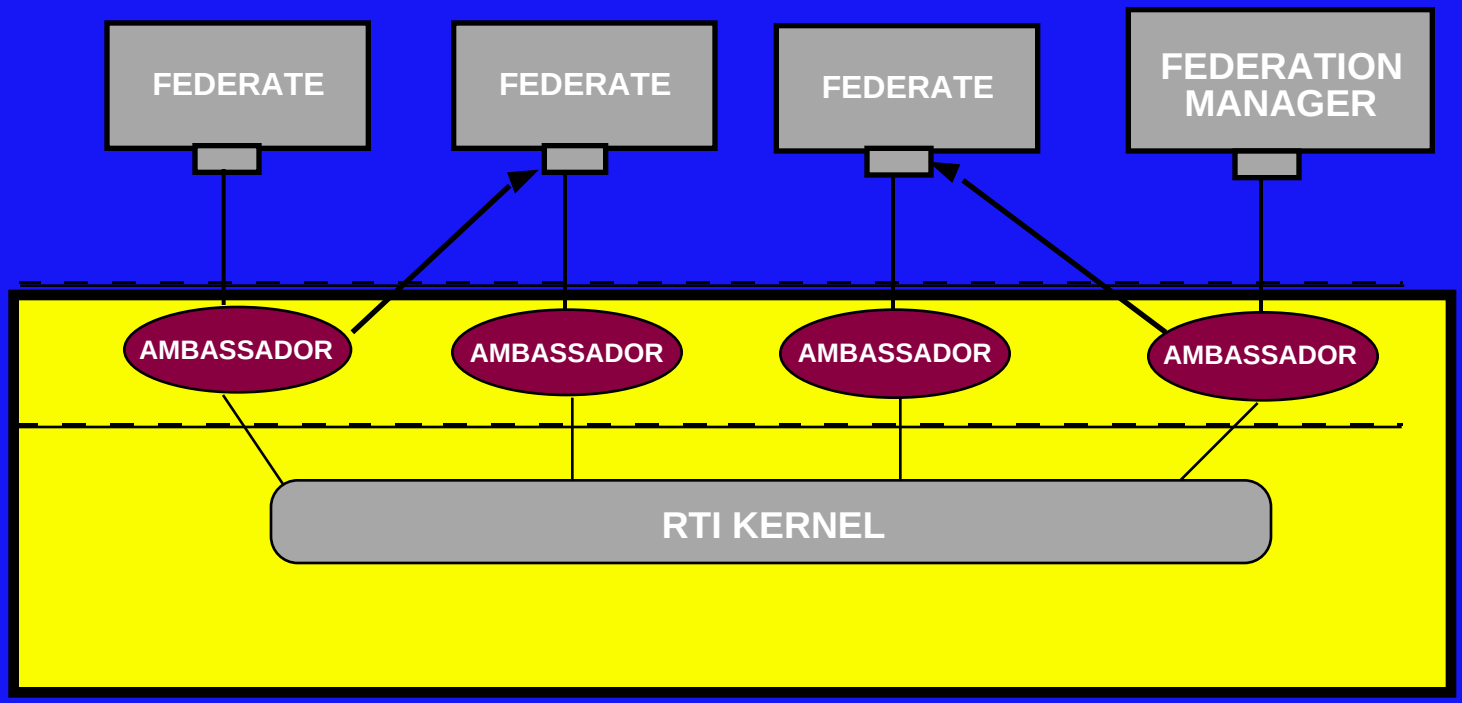


Checkout
- checkout (id, attribute)

Checkin
- checkin (id, attribute, value)

Federates
Product Model
Messages

RTI



RTI

PUBLICATION—DATA TRANSFER

FEDERATE INTERACTIONS WITH EACH OTHER AND RTI

MANAGE DATA DISTRIBUTION—MATCH SUBSCRIBERS TO PUBLISHERS

RTI INTERFACE PART REUSABLE PART FEDERATE SPECIFIC

SBD COMPONENTS

COMPONENT	DESCRIPTION	CAPABILITIES
FedMan	The software module for assembling and managing the runtime execution of an SBD system	Can discover resources • Launch tools (both infrastructure and user), discover resources, store user tools
RTI	An interoperability framework used to provide standards based communications between tools	Basic HLA support • Support useful data transfer commands
SPM	The product process database system. An extensible object oriented framework that contains a collection of domain independent base classes for representing the geometry, behavior, and characteristics of systems, subsystems, and components	Persistent classes, Simple Mesh Generation, Populate from Files • View/edit data from NetScape (including Java) • Domain independent classes (requirements, etc.) • Import Geometry with COTS translators • Multilevel fidelity geometry • Smart Product Catalog • Interface to CAD tools
VDE	A 3D immersive environment for interacting with the SPM	Limited HLA Interface, SPM Interface, Object Manipulation • HLA interface • SPM interface • XServer Display via video textures • Scripting Behaviors • Dynamic Simplification and tessellation
SimBuilder	Definition/control of HLA based exercises for evaluating system design performance	Limited sim discovery, tool launching Limited exercise control, definition, Stealth Viewer (HLA) • Integrated resource discovery and SPM interface • MaK stealth fully integrated to HLA
NetBuilder	A megaprogramming tool for developing data flow based context engines	Single level MDO, Megaprograms for ROI, Automatic hull mesher • Improved looping and branch control • Multilevel MDO
Tools	COTS, GOTS, and custom tools which are of interest to a wide spectrum of SBD users	iSIGHT, simple Hydro, simple Propulsion, Simple Roi • Multilevel collaborative iSIGHT • STAGS

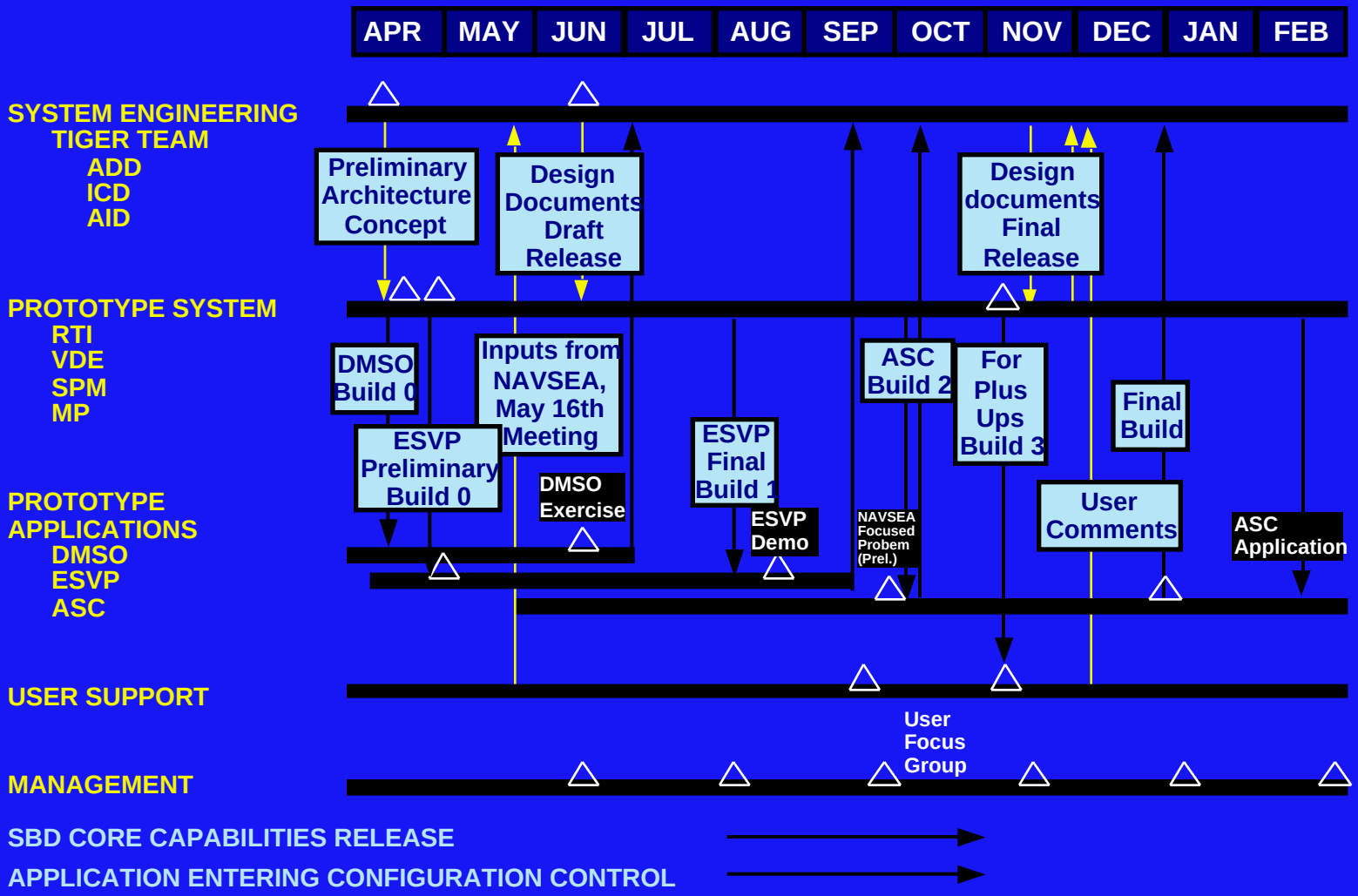
WHAT WE HAVE LEARNED ABOUT HLA ARCHITECTURE

- SINGLE API FOR ARCHITECTURE WORKS WELL
- DIVERSE LEGACY TOOLS CAN BE INTEGRATED
- FOM CAN BE USED TO PROVIDE INTEROPERABILITY OF ENGINEERING TOOLS
- MULTIPLE EXTERNAL DATA SOURCES ARE NEEDED BY INDIVIDUAL FEDERATES
- SPM NEEDS TO BE DYNAMICALLY MODIFIABLE
- LARGE ENTERPRISE MAY HAVE MULTIPLE OVERLAPPING FEDERATIONS

SUMMARY OF ACCOMPLISHMENTS

- SBD USES HLA INTERFACE AS PART OF SBD RTI
- DEVELOPED WRAPPERS TO PORT DIS SIMS TO HLA
- RUN EXERCISES WITH MULTIPLE RTIs
- DEVELOPED A SCALABLE DESIGN FOR THE RTI
- DEVELOPED FEDERATION MANAGEMENT SUPPORT TOOLS
- DEMONSTRATION: IMPACT OF DESIGN CHANGE ON OPERATIONAL PERFORMANCE OF VIRTUAL PROTOTYPES

SBD SCHEDULE

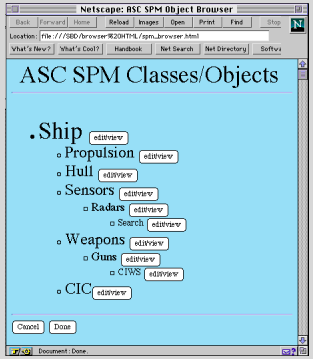


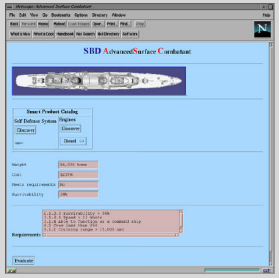
Simulation Based Design

ASC OBJECTIVES

DARPA/TTO

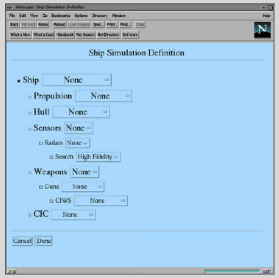
DESIGN BROWSING

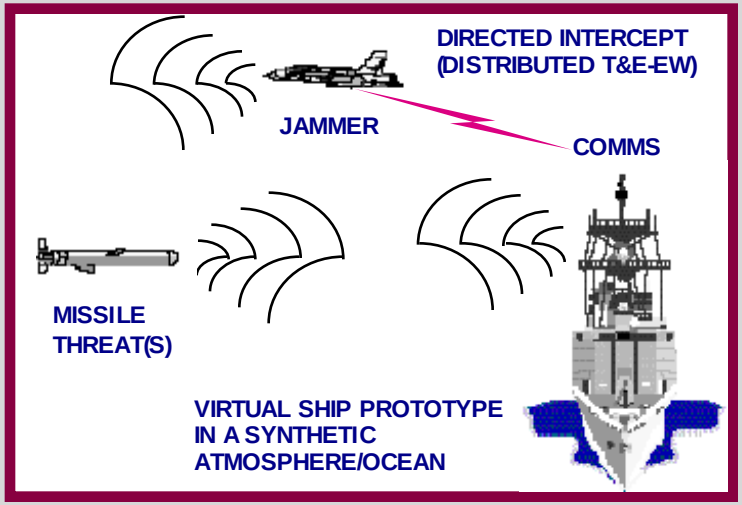




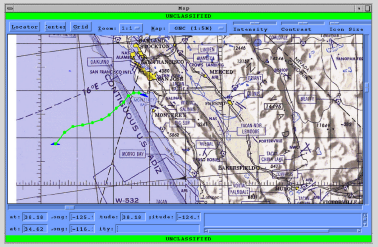
CATALOG COMPONENT SELECTION

SIMULATION DEFINITION

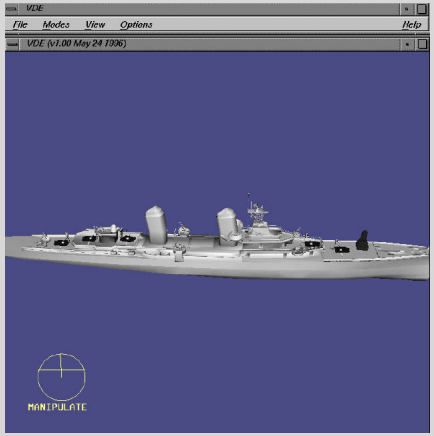




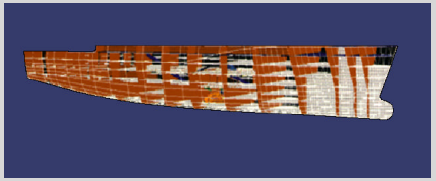
SCENARIO DEFINITION



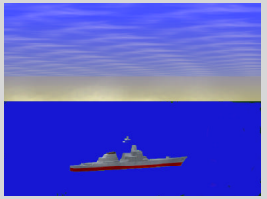
WEAPONS LAYOUT



HULL REDESIGN

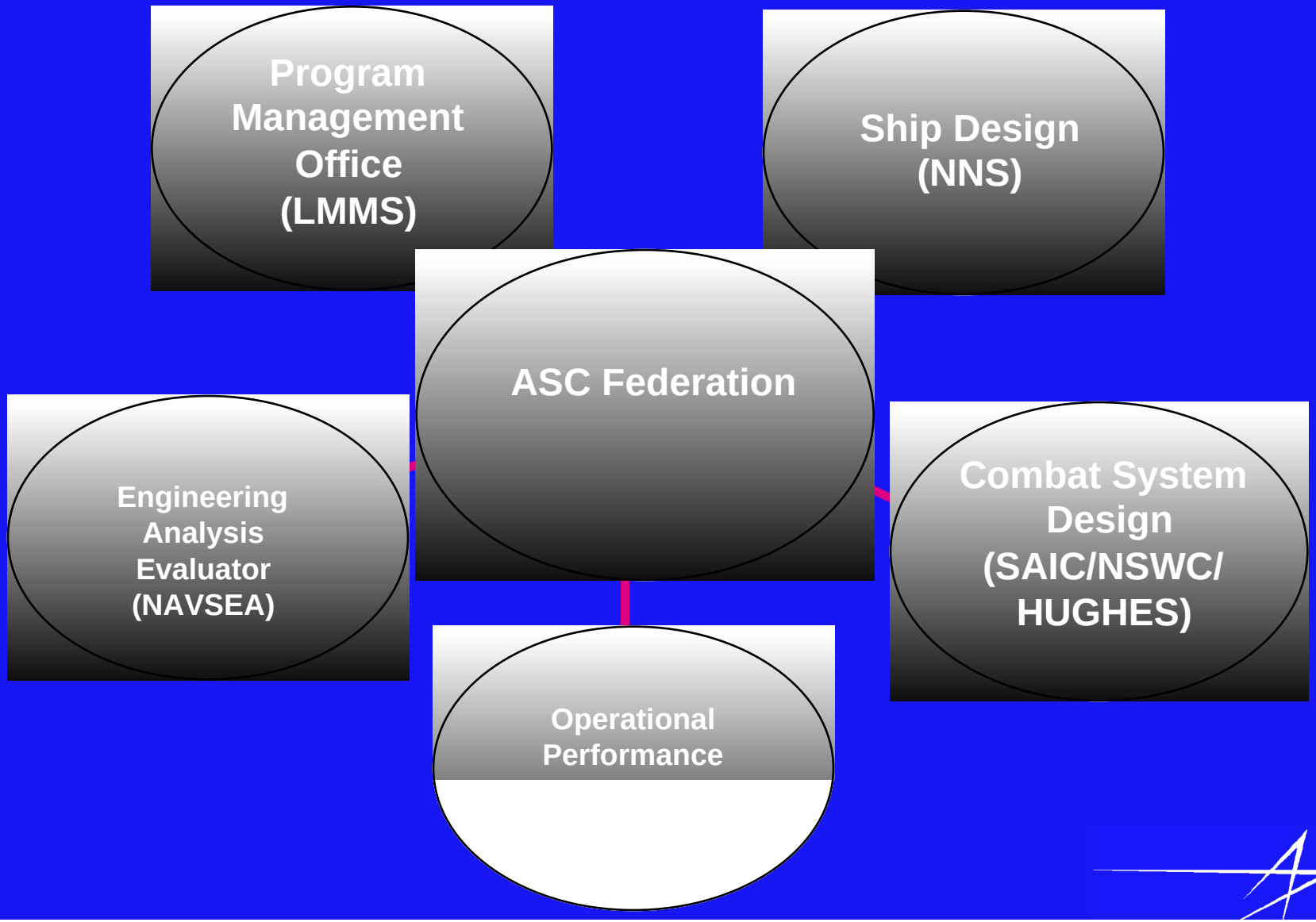


SIMULATION EXECUTION



- **INTEGRATION AND COLLABORATION IN A VIRTUAL ENTERPRISE**
- **SEAMLESS INTEGRATION OF DATA AND TOOLS**
- **MULTIDISCIPLINARY ANALYSIS AND EVALUATION OF COMPLEX SYSTEMS**

ASC FEDERATION



ASC Software Configuration

Simulation Based Design

DARPA/TTO